

### Remarks

The Office Action of September 24, 2008, has been carefully considered.

It is noted that Claims 18, 20 – 27, and 29 – 37, are rejected under 35 U.S.C. 103(a) over WO/41423 to Friedrich.

Claims 19 and 28 are rejected under 35 U.S.C. 103(a) over Friedrich in view of the patent to Sims et al.

Applicant respectfully submits that the claims currently on file differ essentially and in an unobvious, highly-advantageous manner from the constructions disclosed in the references.

In the last filed Amendment, applicant submitted a Declaration in support of the argument that it is not obvious to substitute zirconium for titanium. The Examiner responded as follows:

“Specifically, the declaration does not describe documented results for each material, the procedure that was followed to produce the green tape mixture of zirconium carbide and what type of quality control measurements were performed in order to determine a loss of mechanical flexibility and a change in sample density and discoloration.”

In response thereto, applicant offers the following information. A further declaration by Dr. Bednarz covering this information is being prepared and will be provided as additional support.

The following information uses a sampling of original data obtained during qualification of the matrix samples according to standard test procedures used by Dr. Bednarz. This evidence will show that an MCFC electrolyte matrix tape according to Friedrich, which contains zirconium carbide, shows unacceptable behavior in terms of shelf-life, discoloration, and the required mechanical flexibility, as stated in the Declaration of Dr. Bednarz dated May 20, 2008.

The following four points will be addressed:

- A. fabrication of matrix tape;
- B. characterization of the matrix tape;
- C. test procedure “single-cell 195”; and
- D. results contained different matrix slurry formulation according to the present invention (Bednarz, et al.).

a) **Fabrication of the Matrix Tape (Friedrich: Synthesematrix; Bednarz: Insitumatrix)**

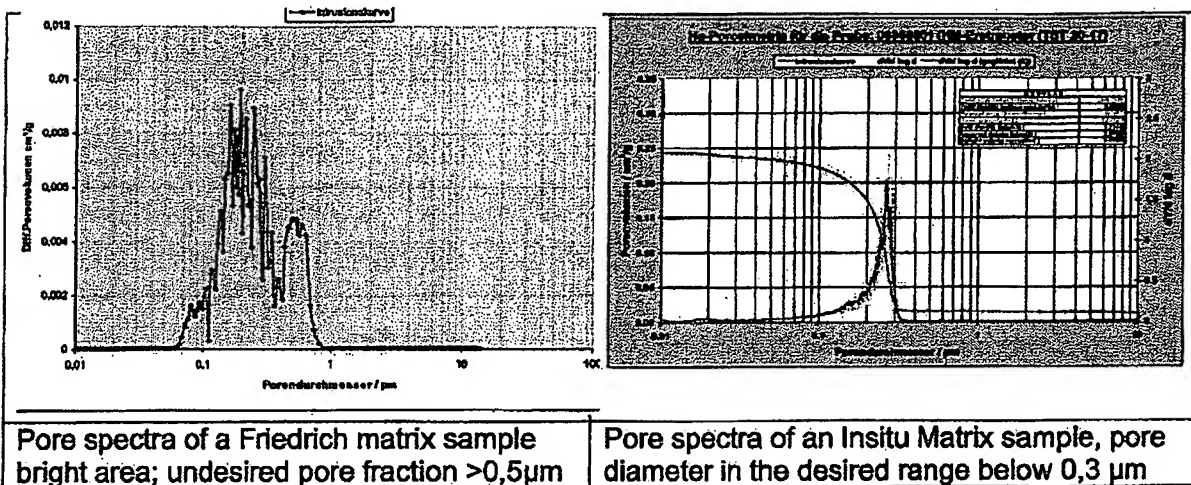
Matrix tapes were manufactured by tape casting a water-based matrix slurry following the matrix slurry formulation according to the Synthesematrix according to Friedrich, and the Insitumatrix according to Bednarz, et al. The tape caster was an in-house built lab machine for sample sizes of 250 by 1000 mm. In the early stage the matrix tapes were dried in ambient temperature and atmosphere overnight.

The matrix slurry was manufactured according to the procedure described by A. Widuch in Attachment 1. The liquids and the microscopic fine powders were mixed and milled for one hour to obtain a so-called pre-slurry. Next, the binder material and the coarse crack-stopping particles were added, this so-called end-slurry was homogenized and de-gassed under vacuum. Within the timeframe of 24 hours the slurry had to be used for casting.

## b) Characterization of the matrix tapes

Matrix tapes are characterized by different measures at MTU Onsite Energy:

- pore deviation by mercury intrusion porosimetry, specification: all pores < 0,4  $\mu\text{m}$
- overall porosity by weight and outer dimensions
- mechanical flexibility by a bending test, bending radius of 100mm without cracking
- shelf time by continuous testing of flexibility over 6 month
- changes in colour, weight or other



The Matrix samples according to Friedrich showed changes in colour within a short periode after manufacturing. This timeframe differed between some days and 2-3 weeks, depending on the exposed atmosphere. The discoloration resulted in round bright spots, that kept on growing, successively covering the entire sample area.

The discoloured regions were significant stiffer than those in the original coloured state, breaking easily during bending tests and the bright spots showed a higher thickness than original and surrounding areas. Additionally, the brighter regions showed an undesired change in pore deviation, coming up with a pore fraction larger than 0,5 $\mu\text{m}$ . This pore fraction leads to incomplete filling with liquid / molten carbonate electrolyte by capillary forces and results in a malfunction of the gas separation function of the electrolyte matrix.

Evidence for this circumstance is shown in section c), showing a single cell test of this matrix type from 2001. Further tests (lab stacks or technology stacks) have never been performed, because this matrix technology according to Friedrich was not continued.

c) Test procedure "single cell 195"

Example: EZ 195 was a 250cm<sup>2</sup> lab single cell operated from 3:00 pm on May 28, 2001 until 7:00 am on July 08, 2001 in Ottobrunn, Bavaria, Germany.

**Teststand 11** 160 mA/cm<sup>2</sup> entspr. 34,1 A!!

**Einzelzelle** : **EZ - 195**

**Versuchsziel** : Synthesematrix in EUROZelle  
Rummelblech aus SS310, e-Kathode,  
BSK, Vorbereitung für LST-16

**Versuchsbeginn** : 28. Mai 01 15:00 Uhr

**Geplante Versuchsdauer** : 1000 Stunden

**Ende des Versuchs** : 8. Jul 01 7:00 Uhr

200 Stunden	5. Jun 01	23:00	Uhr
500 Stunden	18. Jun 01	11:00	Uhr
1000 Stunden	9. Jul 01	7:00	Uhr
1500 Stunden	30. Jul 01	3:00	Uhr

**Teststand 11**

**Einzelzelle** : **EZ - 195**

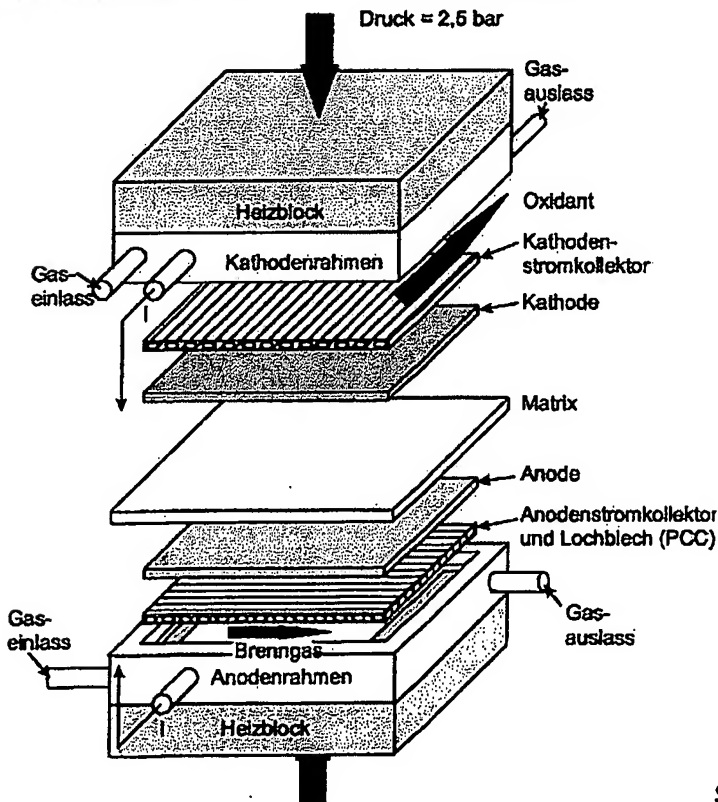
**Versuchsziel** : Synthesematrix in EUROZelle  
Rummelblech aus SS310, e-Kathode,  
Vorbereitung für LST-16

**Versuchsbeginn** : 28. Mai 01 15:00 Uhr

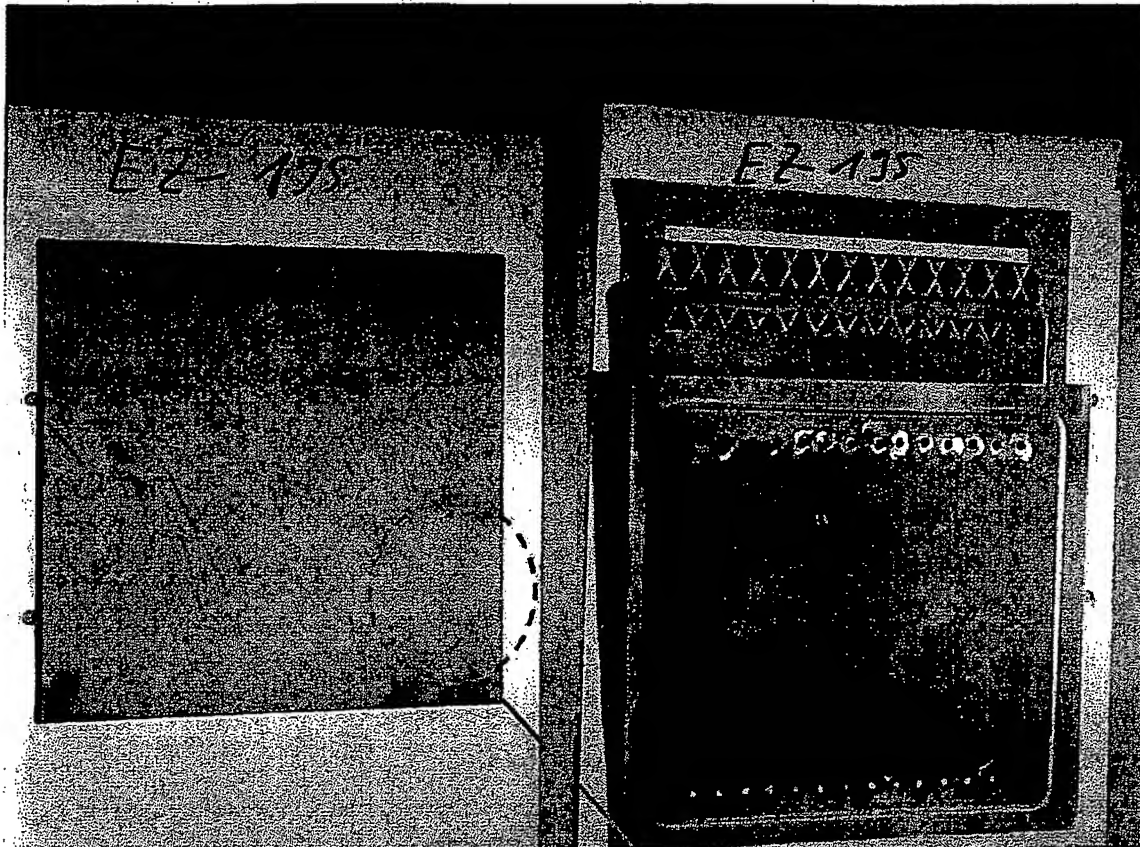
**Ende des Versuchs** : 8. Jul 01 7:00 Uhr

**Versuchsdauer** : 0:00 Stunden

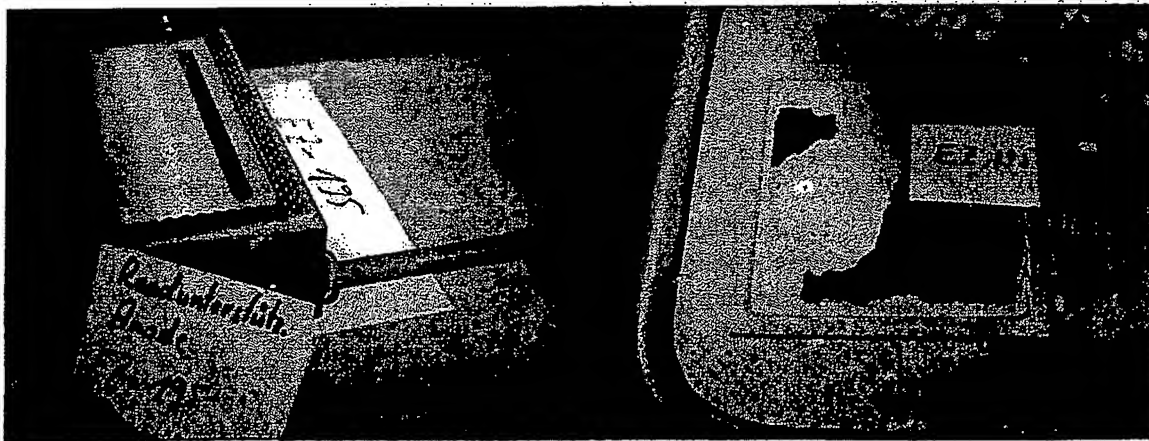
Test content sheet



Setup scetch of a single cell test

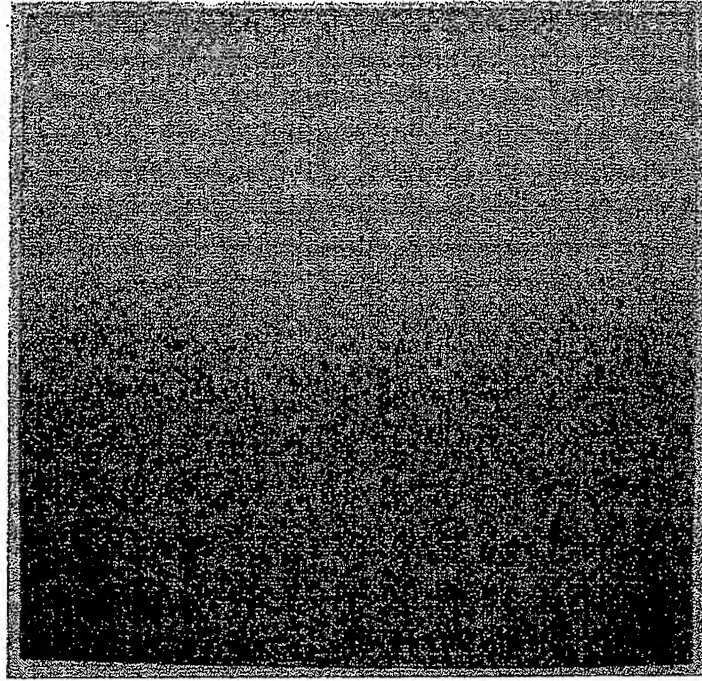


Left picture: Matrix tape (Friedrich) showing bright discolorations (1 week after casting). The brighter regions were stiff and during handling easily cracks were formed at the border of the bright areas. the bright colour and the stiffer mechanical behaviour indicated a polymerization and change in density and pore deviation. Right picture: Single cell test setup

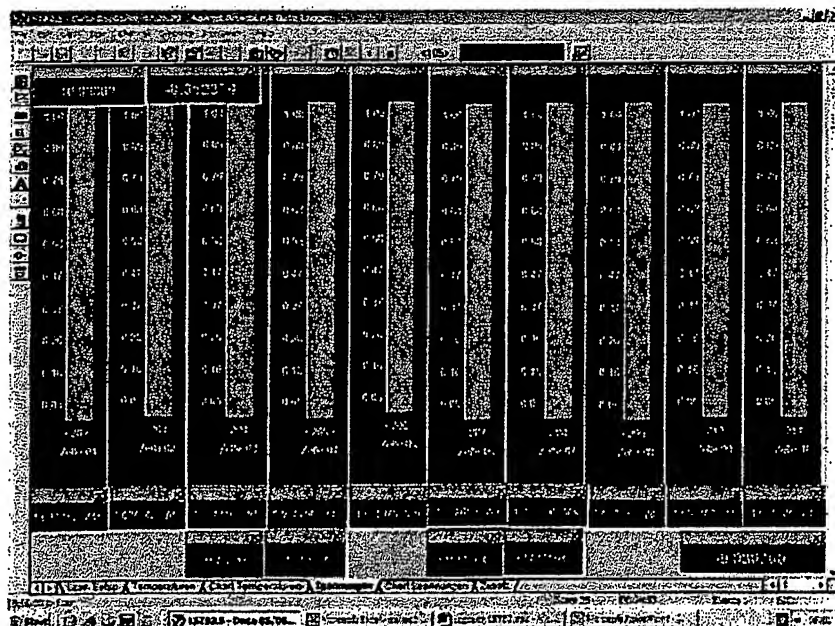


Left picture: single cell support frame of the setup. Right picture: Posttest disassembly observations: The black cathode is partially still on top of the grey-brown matrix layer. Especially the brown region indicates a malfunction of the matrix due to cracks and too coarse porosity, caused by polymerization of the binder system.

d) Results containing the different matrix slurry formulation according to Bednarz et al.



The uniform colour and the uniform mechanical flexibility is constant for at least 6 month, independent of the storing conditions under dried or ambient atmosphere. The shown matrix sample is a 5 month old sample. A number of single cell and lab stack tests as well as full area technology stack tests proved the functionality of the matrices according to Bednarz et al. The pore deviation is given in section b). The functionality is demonstrated by a screenshot of the 10 cell x 250 cm<sup>2</sup> lab stack test LST 85 operated in 2006, showing no differences in OCV (open circuit voltages) between the reference matrix samples in cell No. 1-5 and the Insitu Matrices in cell No. 6-10. Due to the fact that there were NO matrix cracks observed during disassembly and posttest analysis no pictures were taken. From the uniform voltages in the screenshot you directly can see that there is no gas exchange between the gas chambers, so no matrix cracks were existing.



### Conclusion

In view of the above information, together with the previously filed Declaration of Dr. Bednarz, it is respectfully submitted that it would not be obvious to use titanium carbide in place of the zirconium carbide taught by Friedrich. Thus, it is further respectfully submitted that the rejections of the claims under 35 U.S.C. 103(a) are overcome and should be withdrawn.

Reconsideration and allowance of the present application are respectfully requested.

### Fees

If any additional fee is determined to be due, authorization is hereby given to charge the fee to deposit account #02-2275. Pursuant to 37 C.F.R. 1.136(a)(3), please treat this and any concurrent or future reply in this application that requires a petition for an extension of time for its timely submission as incorporating a petition for extension of time for the appropriate length of time. The fee associated therewith is to be charged to Deposit Account No. 02-2275.

Respectfully submitted

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#### CERTIFICATE OF ELECTRONIC TRANSMISSION

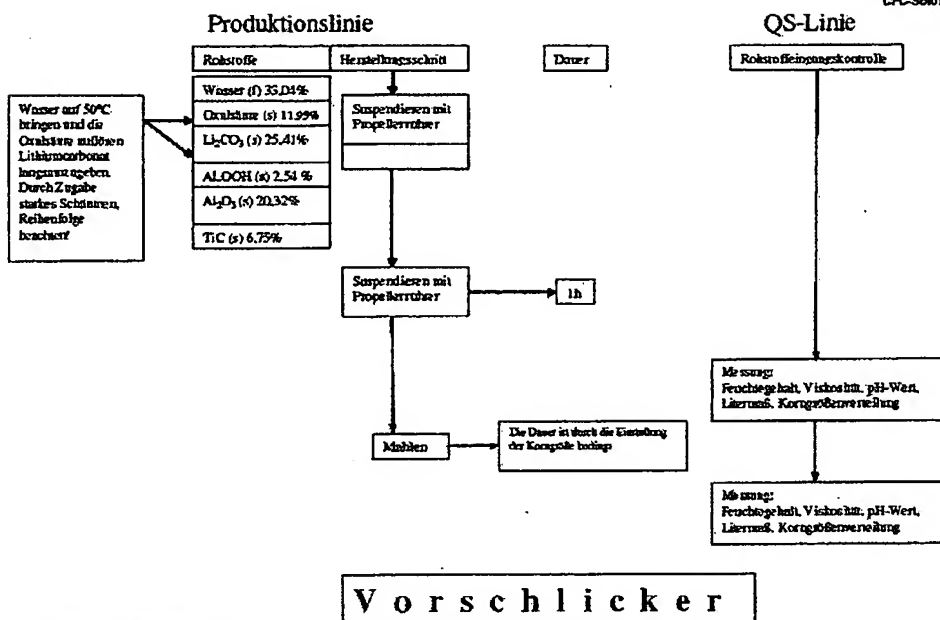
I hereby certify that this document is being electronically transmitted to the Commissioner for Patents via EFS-Web on March 24, 2009.

LUCAS & MERCANTI, LLP

By: 

Klaus P. Stoffel, Reg. No. 31,668

# Attachment 1 (German original flowchart procedure)



Entwickelt von: GFC-TECHNOLOGIES Kompositentechnik GmbH  
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